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ABSTRACT

Experiences with the COMIT system of computer assisted instruction are reviewed in relation to five evaluative criteria: effects on student learning, effects on student attitudes, effects on teachers, institutional effects, and extra-institutional effects. Conclusions are drawn concerning the possible future pedagogical role of the computer assisted learning system. (Author)

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LEARNING FROM COMIT:

THE EDUCATIONAL IMPLICATIONS

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LEARNING FROM COMIT: THE EDUCATIONAL IMPLICATIONS

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Abstract: Experiences with the COMIT System of Computer-Assisted Learning are reviewed in relation to five evaluative criteria: effects on student learning, effects on student attitudes, effects on teachers, institutional effects, and extra-institutional effects. Conclusions are drawn concerning the possible future pedagogical role of computer assisted learning systems.

The impact of the computer on contemporary society has been so great during the past two decades that there are few individuals living in the industrial nations whose daily lives remain untouched by this aspect of modern technology. Education has of course been markedly affected by computers, especially with regard to administration and planning. Paradoxically, however, methods of teaching and learning within the educational system have been remarkably little influenced by the computer in any direct sense -- with the obvious exceptions of the use of computers as tools for numerical computation and as a means of teaching programming skills. This state of affairs is perhaps not as surprising as it may seem if we examine historically the impact on learning of instructional technology -- or indeed the impact of pedagogical innovations in general. On the whole, teaching techniques have been remarkably resistant to change, and it might plausibly be argued that no innovation has had any substantial impact on the way students learn -- at least in the formal education system -- since the invention of the printing press.

COMIT is one of the most sophisticated systems of computer-assisted instruction. As John Moore's introduction to this volume describes, it combines the facilities of a powerful computer with a rich and versatile presentation mode that is capable of supplying moving colour pictures, complex graphics and sound. The student's method of responding is also flexible, permitting communication by sonic pen or keyboard. This is an awesome facility, and it is consequently of immense interest to examine in some detail the attempts that have been made to use the COMIT system and, in particular, to assess the success of the system from an educational and

pedagogical standpoint. In this respect the preceding reports from COMIT course developers have great relevance.

Assessment Criteria:

In attempting to evaluate COMIT, the question immediately arises of what yardsticks are to be used to judge the effectiveness of such an instructional system. I propose to use five criteria: Effects on student learning, Effects on student attitudes, Effects on teachers, Institutional effects, and Extra-institutional effects.

(a) Student Learning. There will be little disagreement among teachers that a principal aim of instruction is to facilitate student learning. Learning, however, is not a unitary concept, and those responsible for the design of instruction must give careful consideration to the particular type and level of learning it is hoped to achieve. Bloom (1956) in his well-known Taxonomy of Educational Objectives [1] lists six types of learning (see Table 1) and it is interesting to note that all six types are represented in the COMIT modules described in the preceding papers.

Table 1. Types of Learning (from B. S. Bloom, Taxonomy of Educational Objectives, 1956)

Knowledge	-- of specifics
	-- of ways and means of dealing with specifics
	-- of the universals and abstractions in a field
Comprehension	-- translation
	-- interpretation
	-- extrapolation
Application	-- use of rules, methods, concepts
Analysis	-- of elements
	-- of relationships
	-- of organisational principles
Synthesis	-- communication
	-- planning
	-- derivation of a set of abstract relations
Evaluation	-- internal evidence
	-- external criteria

Of considerable interest here are the ways used by the different modules to achieve different learning ends. These range from drill-and-practice techniques and remedial instruction, as described by Delahey to teach offensive line play in football, to fairly elaborate simulations of real-life

situations where students are required to apply the knowledge they have attained, achieve some synthesis, and evaluate the efficacy of theoretical notions in relation to the simulated data. A good example of the latter approach is Thompson's programme to teach survey sampling, which exploits a capacity in which the computer excels (storing detailed information and arranging for its retrieval in a variety of different formats) and which would be virtually impossible to achieve by any other teaching technique that can be used in the classroom, as opposed to the "real world".

It is often, erroneously, assumed that the computer should be used to replicate as far as possible the function of the human teacher. (Indeed it is a common error in technological development to devise a machine that performs inefficiently exactly because it is made to ape human performance -- for example the common idea of a robot that looks, walks, and talks like a human would be an incredibly inefficient use of machinery for most purposes.) Computer-Assisted Instruction (as opposed to Computer-Managed Learning, for example) often tends to start from the basis that the learning material should be presented by the computer and confined to this mode of presentation. However, there is no reason why the computer need play such a direct teaching role. It may for instance be used as a learning aid, much like a dictionary or calculator, and indeed this is what Winter has done in using the machine to display various properties of human gait. The computer is also a convenient testing device (it was used for this purpose in nearly all of the COMIT modules) and a useful means of diagnosing each learner's knowledge and abilities so as to guide students to material uniquely suited to their individual needs.

This ability at efficient diagnosis, and the idea that the computer can cater to individual learning differences in a way that is not possible in the classroom, is a potential advantage of CAL that is frequently put forward by the system's advocates. Unfortunately in practice CAL, in common with previous instructional technologies such as programmed instruction, has a rather disappointing record of achievement. In reality, few modules employ very sophisticated diagnosis of student aptitudes (let alone student learning styles) and most of the branching techniques used for remedial purposes are fairly primitive, even in comparison with what was possible on the teaching machines of 15 years ago. There are good reasons why this potential strength of CAL has as yet gone largely unrealized: the deficiency

is probably due largely to the immense effort of time and commitment involved to write and programme material for this purpose. Hence the modules that in principle could cater to a wide variety of individual differences, and which are capable of continual improvement on the basis of a detailed examination of student responses, may remain in a crude and unmodified form indefinitely. Naturally, it is too early to say whether this will be so for the programmes developed in COMIT, although the fact that the system in its present form has been dismantled makes the question somewhat unfair or irrelevant.

If it is accepted that some demonstration of student learning is important evidence of teaching success, then attention turns to the types of evidence that might be useful for this purpose. Evaluation of any teaching intervention may be carried out in terms of a change in knowledge or (in the case of the teaching of a skill) behaviour compared to the abilities demonstrated immediately prior to the start of the teaching. Such "pretest - post-test" comparisons, if they are to be meaningful, should be related to carefully stated learning objectives that can be operationalized in terms of specific behaviour change. (Even then it is often difficult to know whether the change was due to the teaching, to some extraneous factor, or a combination of both.) Sometimes an attempt is made to supplement evidence of such changes on the part of learners by comparative measurements for a group of people to whom the material was presented in some other way (or to whom it was not presented at all). A full discussion of the design and shortcomings of such evaluative strategies is beyond the scope of the present paper. Suffice it to say that several of the contributions to the present collection describe attempts at evaluation that incorporate pre-and post-tests as well as comparisons with other teaching techniques. Some general comments about just what conclusions can be drawn from such studies are made at the end of this paper.

(b) Student Attitudes. A measurement of learners' attitudes to a system of instruction, while less important than evidence of student learning, is of value, not least because favourable attitudes are likely to facilitate learning (or, conversely, unfavourable attitudes are likely to be highly disadvantageous for learning). Nearly all of the preceding papers report on student reactions to their experience with the COMIT system, gathered either by means of a structured questionnaire or from informal interaction

with the module author. As is often the case with teaching innovations (indeed with any teaching technique) both positive and negative attitudes are reported. Negative comments relate to the monotony and lack of flexibility of the system: aspects that different authors attempted to deal with by different means, such as humour or the provision of ancillary notes. Another feature of the system frequently mentioned in a negative vein was its impersonality compared to a real, live teacher, and one attempt to combat this feature and add a "human element" to the learning experience is described by Avedon and Stewart.

This brings up the important question of the "man-machine interface" and the related, more general question of motivation in learning. Unfortunately our knowledge of the process by which humans relate to machines in both positive and negative ways, as well as our understanding of why machines are exciting for some individuals and frightening for others, is disappointing to this point, notwithstanding increasing attention by researchers to the question. It is interesting, for example, that most of McBean's students could spend no more than two or three hours at the COMIT terminal, while we know that students of similar age and intelligence will spend much longer periods passively watching a somewhat similar machine (television) or interacting with machines that seem on the face of it far less challenging (pinball machines, slot machines, and so on).

In terms of positive attitudes to COMIT, many students expressed pleasure at the idea of proceeding at their own pace and being able to review the material presented -- attributes that are not confined to CAL, but are greatly facilitated by such a system. In the case of favourable comments to the general notion of learning via such a system (and there were many such comments) it is important to recognize that there may be a confounding influence caused by the very novelty of the system and the fact that learners were part of a special experiment (the "Hawthorne effect"). On the other hand, some of the negative comments may come from conservative students who are resistant to any new type of learning. Furthermore the greatest area of negative reaction -- which concerned the technical problems with the system -- relates to features of COMIT that could almost certainly be remedied in the future.

(c) Effects on Teachers. The attitudes of authors and instructors to the experience of working with COMIT reflect the same divergence of opinion as do those of the student learners, and range from considerable enthusiasm about the general potential of the system to a measure of disillusionment, with positive attitudes predominating (perhaps not surprisingly in view of the need to justify the great amounts of time and energy expended on preparing the modules). The negative comments were clearly influenced by frustrations with technical aspects of the system (frequent breakdowns and slow response time) and the immense amount of authoring time required.

Of even more interest, however, are the comments by authors about the teaching/learning process itself that have applicability far beyond the COMIT system or computer assisted learning. For example, three of the authors, as a result of working on the preparation of their modules, soon realized that their knowledge of the material and their understanding of the best way to organize the material for efficient learning was far less than they had assumed at the outset, in spite of several years of lecturing on basically the same topics. If this was primarily a self-insight, there were other insights into the learning process itself. For example, four of the authors came to the realization that learning is essentially an active process that requires students to respond constantly and frequently, rather than passively receiving transmitted material, as happens frequently in so much traditional teaching. Authors also commented on another learning principle that is well known to psychologists but frequently ignored in the classroom, the notion that effective learning requires frequent and immediate information to students about how well they are progressing with the learning task. At least one of the authors raised the important issue of social factors in learning, to what extent students benefit from working alone at their own pace as opposed to learning with and from other people. Hence McBean felt that many of his students were able to benefit from being able to work in pairs when reviewing the material in the module.

It is important to realize that these insights about the learning process are not restricted to learning by computer, but are generally applicable. At the same time, it is instructive to see how effectively they were brought home by the experience of working with a new instructional system, such as COMIT, that places new demands on the teacher, especially with regard to the way he or she analyzes, selects, and structures the

material to be learned. Even for experienced teachers it appears that involvement with a new medium of instruction leads to a rethinking of principles and techniques previously taken somewhat for granted. To this extent experience with COMIT is of undoubted benefit to those involved in designing and administering the different modules.

(d) Institutional Effects. Over the three year existence of the COMIT project there was a considerable outlay of institutional funds and resources and an even greater investment of time on the part of the project staff and module authors, not to mention the effort and involvement of the many hundreds of student learners. Yet the essential components of the system have now been disbanded with little likelihood that the University of Waterloo -- at least in the short term -- will change its basic methods of teaching. Why is this the case, and why has this been the fate of so many experiments in educational technology in established educational institutions?

Part of the answer lies in the inherent conservatism of academics -- and students -- when it comes to the implementation of new methods of teaching and learning. Additional reasons relate to the basic complement of skills that most faculty bring to the teaching process (few faculty are trained in pedagogy and most learn through the examples of their own teachers), to the considerable costs involved (to cite just one example, the costs of providing and servicing an adequate number of terminals), and to the general reorganization of the university system that would be required in terms of timetabling, classroom arrangements, and so on. Furthermore, at a time when universities are threatened with severe financial stringencies and the very job security of university teachers is challenged, the political climate is probably not conducive to the introduction of a radical change in teaching methods, especially when the arguments for effectiveness are equivocal. Hence in the immediate future innovations like COMIT will probably remain in the domain of experiments to be tried and tested in forward-looking institutions, by faculty who are willing to devote their time and enthusiasm largely for the reward of their own self-satisfaction and personal insights into the learning process.

(e) Extra-Institutional Effects. In his introduction to this collection Moore states that one aim of the COMIT project was to see what implications might result from the experiment for extramural education. He points out

that this system seems to have particular promise in that its basic component is an ordinary colour television monitor (though supplemented with a number of sophisticated additions, such as a light pen, keyboard, and so on). It seems probable, however, that any hopes to introduce such a system on a widespread basis are rather premature.

In the first place, there appear to be formidable technical obstacles to the efficient operation of such a system, even when it is used "in-house" on a fairly small scale, and with constant technical assistance available to students using each terminal. Secondly, the authoring time required to produce material is vast, especially when it is borne in mind that the segments represented by the modules described here comprise only a fraction of the material normally presented in the one-term courses of which they form part. Thirdly, it is probable that the outside clientele for such a system is probably considerably more conservative about pedagogical matters than the student body in established institutions of higher education. In this regard the British Open University is an interesting case in point. Although this is a remarkable social innovation, from a technological and pedagogical point of view it is fairly orthodox, relying on the traditional mainstays of further education -- correspondence courses, personal tutors, textbooks (albeit extremely well organized ones) and traditional lectures during the compulsory periods in residence. The television component of the Open University is just that -- good television programming, involving none of the interactive element that is a principal feature of COMIT and CAL in general.

COMIT and the Future Role of Computers in Education:

A number of the experiments with COMIT described in previous papers have attempted to compare the system with other teaching methods. In the last analysis, however, such an approach is probably unproductive. Rather, we should try to analyze which media of instruction, including the human teacher, are most suited for particular pedagogical ends and for particular individual learners. This is a research question of great importance, about which very little is known as yet.

In the COMIT system the computer, it could be argued, is best seen not as a teacher, but as a "super-coordinator" of instruction -- potentially better than the human teacher at this task, though whether acceptable in this role by the human learner is something that has yet to

be determined. Certainly COMIT is far from cheap as a coordinating system, even though it is far less expensive in this role than when it is used as a direct teaching device. It must then be asked if it is worth this cost, or whether we shall continue to use our existing systems, largely human, or some alternative non-human, non-computerized system, such as written modules that are capable of guiding learners to a variety of existing resources.

If we accept the computer as a useful coordinator of instructional resources, then we must seriously question the notion that all the material involved has to be presented directly on the computer itself. The system will depend ultimately, I would suggest, not solely on its efficiency, but also on its flexibility. This is the future challenge of computers in education, and an issue for which the COMIT experiment has provided invaluable empirical data.

Reference:

[1] B. S. Bloom, Taxonomy of Educational Objectives: Handbook I. Cognitive Domain, McKay, New York, 1956.